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THE MARINE CLADOPHORAS OF NEW ENGLAND.

F. S. Collins.

(Plate 36.)

There is probably no other genus of algae which has a distribution so universal, both in fresh and salt water, as Cladophora. Its range includes extreme northern and southern latitudes and all regions between, including every possible station where the plant can be submerged all or part of the time. Species of Cladophora sometimes constitute dense attached masses of great extent in lakes and rivers, or floating strata in quiet waters; the fresh water species are not so numerous as the marine, however, and the latter are found in almost every station where algae can grow at all. Exposed rocky shores, quiet bays, still lagoons, marsh creeks, all are apt to abound with these plants. If we except loose sandy beaches, where no algae of any kind can grow, there is probably not a stretch of a few rods in all New England, reached by salt or brackish water, where Cladophoras cannot be found, at least in spring or summer.

There is seldom any difficulty in determining whether a plant belongs to this genus; the generic characters are clear enough, but there is perhaps no genus of New England algae that is so distinct from all other genera as the genus Cladophora, and at the same time contains so many species of vague characters and uncertain limits. Both in the matter of determining a particular specimen collected and in the matter of ascertaining some definite principles, by which the almost innumerable forms may be arranged in natural and easily recognized groups, it offers great difficulties.

Founded in 1843 by Kützing[1] it includes those species of the

[1] Linnaea, Vol. XVII, p. 91, 1843.

older genus Conferva which have fronds composed of repeatedly branching, monosiphonous, articulated filaments. The fruit in all is substantially the same; the contents of practically any cell in the frond may be transformed into numerous zoospores, which escape through an opening in the side wall. The shape of the cell is only slightly if at all changed in this process. Kjellman[1] has attempted to use characters derived from these fruiting cells for the distinction of species among the Scandinavian Cladophoras, but it is doubtful if the characters he uses will be found available generally. There remain for distinction only vegetative characters; — the size of the frond as a whole, the diameter and length of cells in the main filaments and their branches; the arrangement of the latter, alternate, opposite, whorled or secund; the angle at which they issue; their straightness or curvature, acuteness or bluntness; the shade of color; and finally, the presence or absence of special rhizoidal or spinous branches in addition to the normal ramification. All these characters vary much according to external conditions, and also with the age of the individual plant, so that a knowledge of a species as it appears in different environments, and an acquaintance with all stages of growth are necessary before an attempt can be made at drawing specific lines. Add to this the fact that most of the species seem to be still in an evolutionary state, and connected by innumerable intermediate forms, and it will be seen that the identification of a specimen with some one of the 300 described species, often very loosely and insufficiently characterized, is no easy matter.

On the other hand, there is the advantage that none of these characters requires careful microscopic study. In most cases a pocket lens will give all the characters needed, and in some cases even the pocket lens is unnecessary; while a magnification of 40 or 50 diameters will furnish all that can be needed in any case. The trouble is not in perceiving the characters, it is in keeping in mind the type for each species, and deciding what relative weight to give to apparently contradictory characters; to decide what is really characteristic of the species, what due to external conditions.

The number of species occurring on the New England coast is quite limited, but even as to these few the lines of demarcation are

[1] Studier öfver Chlorophycéslägtet Acrosiphonia J. G. Ag. och dess Skandinaviska Arter. Bihang till K. Svenska Vet.-Akad. Handlingar, Band. 18, Afd. III, No. 5, Stockholm, 1893.

indistinct, and their identity with European types is unsettled. Harvey[1] credits to the New England coast 11 species of the 19 which he describes for North America. Farlow[2] gives 14 species and 3 varieties. A familiarity for quite a number of years with the plants as they grow along our shore, has led the writer to conclude that some changes should be made in these lists, and the present paper is intended to give a revised list, with the principal characters; 17 species, 6 varieties and 3 forms being included.

In determining a specimen, a good plate is better than any description, and an authentic specimen in good condition is better than any plate. References have therefore been made in the following pages, under each species, to such books and sets of exsiccatae as are likely to be found at the principal botanical and educational centers, and will be of most assistance to the student. The references to Harvey, LeJolis and Hauck have in almost all cases been verified by authentic specimens in the Farlow Herbarium at Cambridge and in the writer's collection. In the case of the older authors, such as Roth and Dillwyn, authentic specimens have not been obtainable, but wherever there seems to be reason for doubting an identification, the doubt has been indicated. Plate 36, accompanying this paper, is intended to supplement the descriptions, chiefly as to the lesser branches of the various species. The figures should be considered as schematic, rather than as accurate drawings to scale.

Of the three subgenera, Aegagropila, Spongomorpha and Eucladophora, the first is not represented by any marine species in this region. Spongomorpha, with plants densely matted in the lower part or throughout by special hooked branches or by descending rhizoidal filaments, and Eucladophora, which lacks these special branches, are both common. A not absolutely accurate, but perhaps useful key to our species, may be found in the following:

Artificial Key to the New England species of Cladophora.

Filaments matted together by descending rhizoidal filaments or hooked branches in the older parts. SPONGOMORPHA. a

Filaments free or more or less intertwisted, but not matted together by special branches. EUCLADOPHORA. d

[1] Nereis Boreali-Americana, part 3, Smithsonian Contributions to Knowledge, Washington, 1858.

[2] Marine Algae of New England and adjacent coast, Report of the U. S. Fish Commission for 1879, Washington, 1881.

a. Filaments 20–40 μ diameter. *C. lanosa.*
a. " 50 μ diameter or more. b
b. Older parts of the frond abundantly furnished with curved, hooked or circinate branches with very acute tips; cells in older part of frond ½–1 diam. long. *C. spinescens.*
b. Hooked branches few or none; filaments usually increasing in diameter upwards; terminal cells blunt; more or less matted below by rhizoidal filaments. c
c. Filaments about 60 μ below, 100 μ above; cells usually 2–4 diameters long. *C. arcta.*
c. Filaments about 100 μ below, 150–250 μ above; cells, except near the tips, ½–1½ diameters long. *C. Hystrix.*
d. Filaments slender, usually 40–60 μ diameter, pale green, densely interwoven into a spongy mass. *C. albida.*
d. Filaments free or somewhat interwoven, not spongy. e
e. Fronds attached only in the early stages, soon detached and forming dense floating masses in shallow warm water. f
e. Fronds remaining attached throughout the whole active life. g
f. Main filaments 100-150 μ, branches much smaller, divaricate; ultimate ramuli secund. *C. expansa.*
f. Main filaments seldom over 100 μ diameter, branches of successive orders gradually smaller, ultimate ramuli not conspicuously secund. *C. fracta.*
g. Filaments and main branches usually under 100 μ diameter. h
g. " " " " " over 100 μ " l
h. Fronds soft and silky, utterly collapsing when taken from the water. i
h. " firmer. j
i. Cells 6–20 diameters long; plant of sheltered bays. *C. Rudolphiana.*
i. " 2–6 " " ; usually in upper rock tide pools. *C. glaucescens.*
j. Filaments short, rigid, more or less creeping; branches few. *C. Magdalenae.*
j. Fronds freely branched. k
k. Branches recurved, pectinated with similar recurved branchlets. *C. refracta.*
k. Branches regularly flexuous throughout the frond. *C. flexuosa.*
l. Filaments rigid; plants of exposed rocky shores. m
l. Filaments not rigid. n
m. Filaments dark green, branches erect or appressed, opposite or whorled. *C. rupestris.*
m. Filaments lighter in color, ultimate ramuli blunt, short, densely packed at the ends of the branches; branching chiefly alternate. *C. laetevirens.*
n. Filaments 100–250 μ diameter; ultimate ramuli stout, blunt, constricted at nodes. *C. Hutchinsiae.*
n. Filaments 40–150 μ diameter; ultimate ramuli slender, not constricted at nodes. o
o. Filaments with comparatively few main branches, beset throughout with short, patent, often secund ramuli. *C. hirta.*
o. Filaments much branched, branches of successive orders decreasing in size, the tips set with series of secund, patent ramuli. *C. gracilis.*

In considering the species in detail, it appears that the subgenus Spongomorpha should rank higher than Eucladophora, the species of the former having the branches differentiated, part being normal and erect, part rhizoidal and descending; in some species there is a

third type, hooked, curved or circinate, while the normal filaments are straight and erect. In the species of Eucladophora the branches vary in length and diameter, but not otherwise. In Kjellman's paper before mentioned he uses the generic name Acrosiphonia with practically the same extension as Spongomorpha, giving as his reason that the characters given by J. G. Agardh [1] are essential characters of the genus, while those given by Kützing,[2] are non-essential and uncertain. As, however, the earlier name Spongomorpha has been generally received, either as a genus or a subgenus, while Acrosiphonia appears to have been dropped by the author and forgotten, the earlier name can hardly be displaced, under any system of nomenclature. Whether its rank should be generic or subgeneric is more of an open question; in the present paper it is treated as a subgenus. Apart from the question of the rank of Spongomorpha and Aegagropila, there is no question as to the extent and limitations of the genus Cladophora.

Cladophora.

Frond consisting of articulate, branched, monosiphonous filaments, with terminal or intercalary growth. Cells cylindrical or subcylindrical, plurinuclear, with disk-shaped, parietal chromatophores.

Sub-genus Spongomorpha.

Fronds with normal erect filaments, increasing in diameter upwards, with long terminal cell from which cells are successively cut off below; these cells continuing to divide, so that the cells in the older parts of the filaments are much shorter than those in the growing tips; also with descending rhizoidal filaments, and in some species patent, acute, hooked or curved branches, the older fronds being more or less densely matted together by the descending or patent branches.

C. arcta (Dillw.) Kütz.

Kützing, Phyc. Germ., p. 207.
Harvey, Phycologia Britannica, Pl. CXXXV; Nereis Boreali-Americana, part 3, p. 75.

[1] J. G. Agardh, Anadema, Novum Genus Algarum, p. 12, Stockholm, 1848.
[2] Kützing, Phycologia Generalis, p. 273, 1843.

Le Jolis, Algues Marines de Cherbourg, p. 64.
Hauck, Deutschlands Meeresalgen, p. 445.
De Toni, Sylloge Algarum, Vol. I, p. 335.
Farlow, New England Marine Algae, p. 50.
Hauck and Richter, Phycotheca Universalis, Nos. 13, 426.
Collins, Holden and Setchell, Phycotheca Boreali-Americana, Nos. 224, 815.

Conferva arcta, Dillwyn, British Confervae, p. 67, Plate E.

Fronds rich green, in dense tufts, fastigiate, about 60–100 μ diameter, cells 4–6 diameters in the growing tips, 1½–3 diameters in other parts of the frond; erect, stiff, much branched, branches erect or appressed, obtuse or clavate, giving off descending rhizoid-like branches, 40–60 μ diameter, cells several diameters long, by which the lower part of the tuft is firmly matted together.

A spring plant, appearing as early as February in favorable localities; at first a bright rich green, becoming darker and duller in the older plant. Found along the whole New England coast, it is more common and luxuriant in the northern half, less from climatic conditions than from the prevalence of exposed rocky shores, which are its special habitat. At Newport, R. I., where favorable conditions occur, it is abundant and luxuriant.

In most of the references quoted above, the species is taken in a wide sense, and would probably include *C. Sonderi* and *C. spinescens*, here considered distinct. The exsiccatae quoted, however, are *C. arcta* as here understood.

C. HYSTRIX (Strömfelt) De Toni.

De Toni, Syll. Alg., Vol. I, p. 339.
Spongomorpha Hystrix Strömfelt, Om Algvegetation vid Islands Kuster, p. 54.
? *C. Sonderi* Kützing, Phyc. Germ., p. 208.
Hauck, Deutsch. Meeresalg., p. 44.
? *Spongomorpha Sonderi* Kützing, Tab. Phyc., Vol. IV, p. 17, Pl. LXXIX.

Fronds rich green, in rather dense tufts, filaments straight, branches very erect, except in the lower part of the older fronds, where they are more open; about 100 μ diameter at the base, increasing in size upwards, the end cell of the young, vigorously growing filaments sometimes reaching a diameter of 250 μ; cells generally one half to one and one half diameters long, the terminal cell sometimes four diameters. Rhizoidal descending filaments fairly common in the older parts, 40–60 μ diameter, cells 3–10 diameters long.

Resembling a luxuriant *C. arcta*, but the filaments are larger, the cells shorter, the tufts less matted. It has been found at Newfoundland, Isaac Holden; Nahant, Mass., Peak's Island, Maine.

The description given above is based on the Nahant and Newfoundland specimens, and does not agree exactly either with Ström-

felt's description of *Sponogomorpha Hystrix* or with Kützing's of *Cladophora Sonderi.* Strömfelt's plant, however, appears to differ from ours merely in being more luxuriant, the filaments reaching a diameter of 225 μ in the lower part, 360 μ in the upper part, with cell lengths in proportion; the only other character mentioned is that the filaments are often variegated by empty cells alternated with the normal ones. This is hardly a definite character, but is likely to occur from external causes. The variegated character is not noticeable in a specimen of Rosenvinge, from Godthaab, Greenland, No. 162, which in all other respects agrees perfectly with Strömfelt's description.

As regards *C. Sonderi*, the case is not quite so clear; the original description in the Phycologia Germanica reads "Aeste gleichhoch, an der Spitze $\frac{1}{30}$–$\frac{1}{26}$‴, unten bis $\frac{1}{15}$‴ dick; Glieder meist so lang als das Durchmesser, unten bisweilen doppelt länger, oben oft halb so lang." This would indicate that the filaments were twice as large in the basal part as at the tip, but the figure of *Spongomorpha Sonderi* in the Tabulae Phycologicae shows no such distinction, the upper part being a trifle larger, but only a trifle. If the original description is correct, the species does not belong in Spongomorpha at all: if the plate is correct, it would seem that Kützing's name should be retained. I have not been able to examine an authentic specimen, but I have received from Reinbold a specimen from Helgoland, the original locality, which he has marked *C. Sonderi;* it has short joints and filaments largest at the tip, but the size of the filaments is less than in the American plant, thus approaching *C. arcta.*

The largest dimensions are found in specimens from the extreme north, Greenland and Iceland; it may be best to consider it as an arctic species, diminishing in size as it ranges south, and at Helgoland, its extreme southern limit as to conditions though not in latitude, only slightly exceeding *C. arcta.* The latter species has a wider range, plants growing in Greenland and Iceland being practically identical in character and size with plants from the English Channel or from Long Island Sound. That the typical *C. arcta* is found at Iceland in company with but distinct from *C. Hystrix*, speaks strongly for their being distinct species.

C. SPINESCENS Kütz.

Kützing, Species Algarum, p. 418.
C. arcta var. *centralis* Collins, Holden & Setchell, Phyc. Bor.-Am., No. 721.
Spongomorpha spinescens Kützing, Tab. Phyc., Vol. IV, p. 16, Pl. LXXVIII.

Main filaments about 80 μ, cells $\frac{1}{2}$–1 diam., growing tips up to 100 μ diam., cells 2 diam. long. Branches either erect and somewhat clavate, or patent and acute; branches of the latter type either short and spine-like or long, hooked, revolute or even circinate. The

descending rhizoidal filaments are not uncommon, but the matting together of the fronds is due more to the peculiar hooked branches.

From *C. arcta*, under which it is included by most authors, it differs by the acute hooked branches, shorter joints, and the less fastigiate character of the frond. This last character, though apparently constant in American specimens, is not uniform in European forms, some of them being reported as quite level topped. In *C. arcta*, except in older stages, the flat or rounded top of the frond is very noticeable, while the American *C. spinescens*, even in the younger stages, has more the form of rope-like, many times branched fronds; somewhat like *Ectocarpus tomentosus*. *C. arcta* is a plant of early spring, and grows on rocks; *C. spinescens* is nearly always epiphytic, and is in excellent condition in July, when only battered forms of *C. arcta* are to be found.

It has been collected by the writer at Nahant, Mass., at St. George's Bay, at Pemaquid, and at Mt. Desert, Maine.

C. LANOSA (Roth) Kütz.

Kützing, Phyc. Gen., p. 269.
Harvey, Phyc. Brit., Pl. VI; Nereis Bor.-Am., part 3, p. 76.
Le Jolis, Alg. Mar. Cherb., p. 63.
Farlow, N. E. Marine Algae, p. 51.
Hauck, Deutsch, Meeresalg., p. 447.
De Toni, Syll. Alg., Vol. I, p. 336.
Hauck & Richter, Phyc. Univ., No. 276.
Collins, Holden & Setchell., Phyc. Bor.-Am., No. 661.
Farlow, Anderson & Eaton, Alg. Am.-Bor. Exsicc., No. 204.
Conferva lanosa Roth, Cat. Bot., Vol. III, p. 291.

Filaments 30–40 μ diam., light green, cells 2–6 diam. Fronds fastigiate, branches erect, blunt, more or less matted at the base by descending rhizoidal filaments, slightly smaller than the main filaments. Epiphytic on various algae.

This species is quite distinct, and has been maintained unchanged since its establishment in 1806. It is found along the whole New England coast. It appears in April, is in good condition in May and June; in the latter part of June and in July the fronds become detached, and float ashore in the form of soft, round, pale green tassels, two or three centimeters in diameter.

C. LANOSA var. UNCIALIS (Fl. Dan.) Thuret.

Thuret in Le Jolis, Alg. Mar. Cherb., p. 63.
Farlow, N. E. Marine Algae, p. 51.
Hauck, Deutsch. Meeresalg., p. 447.
De Toni, Syll. Alg., Vol. I, p. 336.
Collins, Holden & Setchell, Phyc. Bor.-Am., No. 77.
C. uncialis Harvey, Phyc. Brit., Pl. CCVII; Nereis Bor.-Am., part 3, p. 77.
Conferva uncialis Fl. Dan., Pl. DCCLXXI, fig. I.

Tufts irregular in outline, not fastigiate except in early stages. Growing on rocks.

In size and character of filaments hardly distinguishable from the type, but forming, when well developed, irregular tufts, reminding one of *C. spinescens*. It is saxicolous, and the fronds do not float away bodily at maturity, like *C. lanosa* type, but persist in a battered and unattractive state through the summer. It is found along the whole New England coast.

Sub-genus Eucladophora.

All branches similar, not increasing in size upwards, terminal cell short, adult cells not subdividing.

C. albida (Huds.) Kütz.

Kützing, Phyc. Gen., p. 267.

Harvey, Phyc. Brit., Pl. CCLXXV; Nereis Bor.-Am., part 3, p. 80.

Le Jolis, Alg. Mar. Cherb., p. 59.

Farlow, N. E. Marine Algae, p. 51.

Hauck, Deutsch. Meeresalg., p. 458.

De Toni, Syll. Alg., Vol. I, p. 525.

Conferva albida Hudson, Flora Anglica Ed. 2, p. 595.

Fronds soft, dense, pale green, filaments 20–30 μ [1] diam., cells 4–5 diam., delicate; branching irregular, ultimate ramuli long, patent, blunt.

Rather common in southern New England, usually easily distinguished by the spongy character of the frond and the slender filaments.

C. albida var. refracta (Wyatt) Thuret.

Thuret in Le Jolis, Alg. Mar. Cherb., p. 60.

Collins, Holden & Setchell, Phyc. Bor.-Am., No. 720.

Cladophora refracta Harvey, Phyc. Brit., Pl. XXIV; Nereis Bor.-Am., part 3, p. 79.

De Toni, Syll. Alg., Vol. I, p. 324.

Conferva refracta Wyatt, Algae Danmonienses, No. 228.

Like the type in character of frond and size of filaments, but with recurved branches in the upper part of the frond, set with recurved ramuli. *C. refracta* has similar branches and ramuli, but is a much coarser plant. Some forms of *C. flexuosa* are puzzling, but the main branches in the latter are larger than anything in *C. albida*, and neither *C. refracta* nor *C. flexuosa* has the spongy substance of *C. albida*. It occurs probably all along the New England coast, but

[1] When the diameter of the filament is given in this form, for species of the subgenus Eucladophora, the larger dimensions are for the main filaments, the smaller for the ramuli; in the subgenus Spongomorpha the normal branches increase in size upward, and the larger dimensions refer to the tips.

is more common in the south. There has been much confusion as to the plant to be called *C. refracta*; there seems to be no way of ascertaining what was Roth's *Conferva refracta*, but Wyatt's plant is without much doubt a variety of *C. albida*.

C. RUDOLPHIANA (Ag.) Kütz.

Kützing, Phyc. Gen., p. 268.
Harvey, Phyc. Brit., Pl. LXXXVI; Nereis Bor.-Am., part 3, p. 80.
Farlow, N. E. Marine Algae, p. 54.
Hauck, Deutsch. Meeresalg., p. 457.
De Toni, Syll. Alg., Vol. I, p. 321.
Collins, Holden & Setchell, Phyc. Bor.-Am., No. 267.
Conferva Rudolphiana Agardh, Flora, 1827, p. 636.

Fronds long and loose, yellowish green, gelatinous, branches often opposite, patent, flexuous, ultimate ramuli secund, tapering; cells 20–60 μ diam., much longer than broad, sometimes up to 20 diameters.

A plant of warm, shallow bays chiefly, growing on stones or algae, below low water mark, often in large quantities; the individual fronds sometimes a meter in length, always soft and gelatinous. It is common from Nantucket to New York, but only occasionally found north of Cape Cod; the northernmost point being Kennebunkport, Maine. Herbarium specimens of *C. Rudolphiana*, *C. albida* and some forms of *C. gracilis* are not always readily to be distinguished, microscopic characters only being available; but the living plants can usually be recognized. *C. albida* is very soft and spongy; *C. Rudolphiana* soft but not spongy; *C. gracilis*, even in its slenderest forms, has a certain harshness to the touch, as compared with the two other species.

C. GLAUCESCENS (Griff.) Harv.

Harvey, Phyc. Brit., Pl. CXCVI; Nereis Bor.-Am., part 3, p. 77.
Le Jolis, Alg. Mar. Cherb., p. 60.
Farlow, N. E. Marine Algae, p. 52.
Hauck, Deutsch. Meeresalg., p. 460.
De Toni, Syll. Alg., Vol. I, p. 320.
Farlow, Anderson & Eaton, Alg. Am.-Bor. Exsicc., No. 205.
Collins, Holden & Setchell, Phyc. Bor.-Am., No. 817.
Conferva glaucescens, Griffiths in Wyatt, Alg. Danm., No. 195.

Fronds 10–40 cm. long, loosely tufted, glaucous or yellowish green, much branched, ultimate ramuli long, erect, acute, sometimes secund, filaments delicate, 30–60 μ diam.

A plant of spring and early summer, found all along our coast and extending south to Florida and north to Labrador. It grows both in quiet bays and in tide pools on rocky shores, especially upper pools where the water becomes quite warm from the sunshine between one high tide and another. In these pools the natural bright glaucous

green is changed in the upper part of the frond to yellowish green or almost white.

The *C. glaucescens* of the Phycologia Britannica is figured and described as having articulations uniformly near three diameters. The plant of northern New England has cells usually 4–6, sometimes even 12 diameters, agreeing with Hauck's description. This difference in the length of the articulations is of little importance, other characters being identical.

C. FLEXUOSA (Griff.) Harv.

Harvey, Phyc. Brit., Pl. CCCVIII; Nereis Bor.-Am., part 3, p. 78.
Le Jolis, Alg. Mar. Cherb., p. 60.
Farlow, N. E. Marine Algae, p. 54.
Hauck, Deutsch. Meeresalg., p. 456.
De Toni, Syll. Alg., Vol. I, p. 311.
Farlow, Anderson & Eaton, Alg. Am.-Bor. Exsicc., No. 206.
C. gracilis Collins, Holden & Setchell, Phyc. Bor.-Am., No. 724. Not typical.
Conferva flexuosa Griffiths in Wyatt. Alg. Danm., No. 227; not of Dillwyn nor Jürgens.

Light green, fronds 10–20 cm. high, main filaments 80–120 μ diam., branches 40–80 μ, quite regularly flexuous, bearing alternate or secund, curved and sometimes refracted ramuli; articulations in branches 2–3 times as long as broad, in main stems up to 6 diam. Growing chiefly in rock pools, usually nearer low water mark than *C. glaucescens*, from which it is also distinguished by a firmer texture, less luxuriant branching, curved ramuli, and uniformly flexuous filaments. It is not so easy to distinguish well developed plants of *C. flexuosa* from small forms of *C. gracilis*, *C. hirta* or *C. laetevirens*, but normal forms can be fairly well made out, by the difference in the size of the filaments. It occurs all through our range, and as far north as the Gut of Canso, Macoun, and is in its best estate in July.

C. FLEXUOSA forma **densa** Collins ms.

Branching of all orders very dense, texture of frond spongy.

In habit much like *C. albida*, but in dimensions of cells and form of branches like typical *C. flexuosa*. Found growing in dense masses at low water mark, Easton's Point, Newport, R. I.

C. GRACILIS (Griff.) Kütz.

Kützing, Phyc. Germ., p. 215.
Harvey, Phyc. Brit., Pl. XVIII; Nereis Bor.-Am., part 3, p. 81.
Farlow, N. E. Marine Algae, p. 55.
Hauck, Deutsch. Meeresalg., p. 457.
De Toni, Syll. Alg., Vol. I, p. 322.
Farlow, Anderson & Eaton, Alg. Am.-Bor. Exsicc., No. 209.
Conferva gracilis Griffiths in Wyatt, Alg. Danm., No. 97.

Fronds up to 30 cm. long, yellowish or glaucous green, main filaments up to 160 μ diameter, irregularly bent, branching at the angles,

the branches more slender, beset at the tips with long, secund, attenuate, acute branchlets, 40–60 μ diam., cells 3–5 diam.

It is very difficult to give a description of this species that will enable a stranger to recognize it, and yet, in its typical form, it is fairly distinct. It is very variable, passing into *C. flexuosa*, *C. hirta* and *C. laetevirens*. In its typical form it has not the uniformly flexuous filaments of the first, the abundant short ramuli of the second, nor the stout fastigiate ramuli of the third; but forms partaking in greater or less degree of all these characters are only too common. North of Cape Cod the prevailing form is elongated, with very erect branches; this form is occasionally found south of Cape Cod, but the more common form has more patent branching, giving quite a different aspect, though there are no technical distinctions. Farlow's description in the N. E. Marine Algae fits best with the southern form, as does also No. 209, Alg. Am.-Bor. Exsicc., quoted above; this southern form is nearer *C. flexuosa* than the northern form. No. 206 of the same is quite typical *C. flexuosa*; No. 724 of Phyc. Bor.-Am. is between the two, but should be ranged under *C. flexuosa* rather than, as distributed, under *C. gracilis*.

It is a summer and autumn plant, preferring sheltered places, sometimes occurring in large quantity in muddy bays and harbors, and it is found all along our coast. One form and two varieties can be distinguished by name.

C. GRACILIS forma **elongata** Collins.

Collins, Holden & Setchell, Phyc. Bor.-Am., No. 725.

Fronds attached, with few and erect branches, stretching out on the surface of the water for a meter or more; color very glaucous green.

An extreme development of the ordinary northern form, apparently conditioned by its location, shallow warm water pools, on islands in Penobscot Bay, Maine.

C. GRACILIS var. EXPANSA Farlow.

Farlow, N. E. Marine Algae, p. 55.

Frond soon detached, forming loose floating masses, irregularly branched.

With the habit of *C. expansa*, but not forming a dense felt, floating loosely in the water of tide pools etc.; Gloucester, Nahant, Mass., W. G. Farlow; Cape Rosier, Maine, F. S. Collins.

C. GRACILIS var. **vadorum** (Aresch.)

C. gracilis var. *tenuis* Thuret in Le Jolis, Alg. Mar. Cherb., p. 61.

Farlow, N. E. Marine Algae, p. 55.

Conferva vadorum Areschoug, Alg. Exsicc., No. 19.

Filaments slender, 40–100 μ, branches few, articulations 4–8 diam.

Forming indefinite masses below low water mark, Gloucester, Mass., Farlow; Atlantic City, N. J., S. R. Morse.

Areschoug's name having been published in 1840, it would seem

that it should be retained as a varietal name, in preference to Thuret's var. *tenuis*, published in 1863.

C. HIRTA Kütz.

Kützing, Phyc. Germ., p. 208.
Le Jolis, Alg. Mar. Cherb., p. 60.
Hauck, Deutsch. Meeresalg., p. 456.
De Toni, Syll. Alg., Vol. I, p. 329.
Collins, Holden & Setchell, Phyc. Bor.-Am., No. 726.

Filaments rather stiff, 50–200 μ diam., more or less bent, more or less branched, beset throughout or nearly so with short, usually secund, subacute ramuli; articulations 2–4 diam., rarely 6.

Somewhat resembling *C. gracilis* and probably having passed under that name; but it is coarser than most forms of the latter, and has not the long slender ramuli at the tips of the branches. The extent of ramification varies much, some forms having filaments a decimeter long with no branches other than the short ramuli which occur, several on one side and several on the other, or sometimes nearly all on one side, over the whole or the greater part of the frond. Sometimes the tip of a branch is quite bare, while all the lower part has the secund ramuli.

It occurs throughout our range, mostly in rather exposed places, but seems to be not so common as some other species; this, however, may be due to its having only recently been distinguished from *C. gracilis* in this country.

C. EXPANSA (Mert.) Kütz.

Kützing, Tab. Phyc., Vol. III, p. 27, Pl. XCIX.
Le Jolis, Alg. Mar. Cherb., p. 61.
Farlow, N. E. Marine Algae, p. 55.
Hauck, Deutsch. Meeresalg., p. 462.
De Toni, Syll. Alg., Vol. I, p. 319.
Farlow, Anderson & Eaton, Alg. Am.-Bor. Exsicc., No. 210.
Collins, Holden & Setchell., Phyc. Bor.-Am., No. 121.
Conferva expansa Mertens in Jürgens, Decade 8.

Fronds dull green, loosely branched, the main branches 100–150 μ diam., flexuous, with smaller, patent, secondary branches, divaricately divided; ultimate ramuli 40 μ diam. secund, blunt, articulations 3–6 diam.; at first attached but soon loosened and floating.

Common in shallow pools and especially in lagoons where the water is warm and the level varies little; here it forms a thick felty coating on the surface of the water, usually in company with *Lyngbya aestuarii* and species of Enteromorpha. It is found throughout our whole range.

C. EXPANSA var. GLOMERATA Thuret.

Thuret in Le Jolis, Alg. Mar. Cherb., p. 61 (without description).

Ultimate ramuli in closely set tufts; quite different in habit from the type, but evidently not specifically distinct.

Bridgeport, Conn., Isaac Holden.

C. FRACTA forma MARINA Hauck.

Hauck, Deutsch. Meeresalg., p. 461, excluding synonymy.
Hauck & Richter, Phyc. Univ., No. 68.
C. fracta Harvey, Phyc. Brit., Pl. CCXCIV; Nereis Bor.-Am., part 3, p. 83, as to marine forms.
Le Jolis, Alg. Mar. Cherb., p. 59.
Farlow, N. E. Marine Algae, p. 56; not of list of algae of Southern N. E.

Tufts irregular, dull green; filaments somewhat stiff, 80–120 μ diam., sparingly and somewhat dichotomously divided; branches spreading, angularly bent, with few and irregular quite blunt ramuli; articulations usually 3–6 diam.

C. fracta is an abundant and very variable species in fresh water, the world over, but occurs only occasionally in salt water, and may perhaps be considered less a true marine plant than as a stray form, out of its normal element. Still it does occur in submarine and even distinctly marine stations on many coasts, and must have a place in any marine list. Its nearest ally is *C. expansa*, a more freely and regularly branched plant; characteristic forms can readily be distinguished, but there are many forms, especially old and worn individuals, where the line is hard to draw. Indeed, old and battered specimens of any species of Cladophora make fairly good *C. fracta*.

C. FRACTA forma **flavescens** (Harv.).

C. flavescens Harvey, Phyc. Brit., Pl. CCXCVIII.

Filaments more slender than in the type, usually 30–60 μ diam.; articulations 6–10 diameters, ultimate ramuli tapering but with blunt tips; forming dense floating masses in high, warm pools.

Marblehead, Mass.; Rockaway, Long Island, N. Y.

C. MAGDALENAE Harv.

Harvey, Phyc. Brit., Pl. CCCLV, A.
Le Jolis, Alg. Mar. Cherb., p. 59.
Farlow, N. E. Marine Algae, p. 56.
De Toni, Syll. Alg., Vol. I, p. 325.
Collins, Holden & Setchell, Phyc. Bor.-Am., No. 572.

Fronds short, coarse, dull green, matted, procumbent, with patent, flexuous branches, which have a few irregularly arranged, curving ramuli; filaments 60–100 μ diam., articulations 2–4 diam.

In some respects seeming like a form of *C. fracta*, but apparently as distinct as can be ordinarily expected of a Cladophora. It grows among other algae between tide marks, creeping in entangled masses. It has been found only in two localities; Napatree Point, R. I., D. C. Eaton; Milford, Conn., Isaac Holden.

C. REFRACTA (Roth) Areschoug.

Areschoug, Alg. Exsicc. Scand., No. 338; not Phyc. Brit., Pl. XXIV nor De Toni, Syll. Alg., Vol. I, p. 324.

Farlow, N. E. Marine Algae, p. 52.
Farlow, Anderson & Eaton, Alg. Am.-Bor. Exsicc., No. 207.
Collins, Holden & Setchell, Phyc. Bor.-Am., No. 573.
C. hamosa var. *refracta* Hauck, Deutsch. Meeresalg., p. 457.
Hauck & Richter, Phyc. Univ., No. 272.
? *Conferva refracta* Roth, Cat. Bot., Vol. II, p. 193.

Filaments rather stiff, 40–120 μ diam., articulations 2–3 diam., glaucous green; branches flexuous, the secondary branches and those of subsequent orders at first erect, then reflexed; ultimate ramuli often secund, blunt.

A common form in rocky pools throughout our whole range, and not very variable. It has a characteristic habit, not easy to describe, but recognized without much difficulty, even in mounted specimens, when once known; but forms of *C. flexuosa* sometimes resemble it pretty closely.

There is uncertainty as to what *Conferva refracta* Roth really was, but the *Cladophora refracta* of Areschoug seems to be a fairly distinct species, while the *C. refracta* of French algologists is apparently a variety of *C. albida*.

C. RUPESTRIS (L.) Kütz.

Kützing, Phyc. Gen., p. 270.
Harvey, Phyc. Brit., Pl. CLXXX; Nereis Bor.-Am., part 3, p. 74.
Le Jolis, Alg. Mar. Cherb., p. 63.
Farlow, N. E. Marine Algae, p. 51.
Hauck, Deutsch. Meeresalg., p. 452.
De Toni, Syll. Alg., Vol. I, p. 328.
Collins, Holden & Setcheil, Phyc. Bor.-Am., No. 728.
Conferva rupestris Linnaeus, Syst. Nat., Edit. 12, Vol. II, p. 721.

Filaments dark green, 80–150 μ diam., articulations 3–4 diam.; fronds densely tufted, much branched, the branches opposite or in fours, erect, ultimate ramuli short, blunt or slightly subulate.

In the confusion that exists in this unhappy genus, it is pleasant to find one species about which there can be no mistake, and *C. rupestris* is nearly unmistakable, with its dense, dark, stiff tufts with opposite or whorled branches. It is a rather handsome plant while growing, but herbarium specimens seem coarse, and do not adhere well to paper. It grows on rocks near low water mark, often covered by Fuci, and seems to be in good condition all through the year, while most Cladophoras are spring and summer plants. It is common from Nahant north, and is also found at Gay Head, Farlow.

The plant is figured and described by Harvey as having subulate ramuli, but in most American specimens examined the ramuli are blunt; in a few cases only are they slightly acuminate.

C. LAETEVIRENS (Dillw.) Harv.

Harvey, Phyc. Brit., Pl. CXC; Nereis Bor.-Am., part 3, p. 66.

Farlow, N. E. Marine Algae, p. 53.
C. laetevirens var. *glomerata* Le Jolis, Alg. Mar. Cherb. p. 82.
C. utriculosa var. *laetevirens* Hauck, Deutsch. Meeresalg., p. 455.
Conferva laetevirens Dillwyn, British Confervae, Pl. XLVIII, p. 66.

Filaments 50–150 μ diam., rigid, yellow green, much branched; branches erect, often opposite; ultimate ramuli short, obtuse or subacute, densely fastigiate at the tips of the branches; fronds up to 20 cm. long, articulations of main branches 6, of ramuli 3 diameters.

A stout and rather coarse species, perhaps best distinguished by the dense tufts at the ends of the branches, with blunt ramuli not much smaller than the branches. It is found from Nahant north, in exposed lower pools or below low water mark, but does not seem to be very common. Battered forms of *C. gracilis* or *C. hirta* are not easily distinguished from it, though when in good condition there is little danger of their being confused.

C. HUTCHINSIAE (Dillw.) Kütz.

Kützing, Phyc. Germ., p. 210.
Harvey, Phyc. Brit., Pl. CXXIV.
Farlow, N. E. Marine Algae, p. 53.
Hauck, Deutsch. Meeresalg., p. 453.
De Toni, Syll. Alg., Vol. p. 314.
Conferva Hutchinsiae Dillwyn, Brit. Confervae, p. 65, Pl. CIX.

Frond rather glaucous green, up to 40 cm. high; filaments 120–300 μ diameter, stiff, flexuous, sparingly branched; ultimate ramuli few, secund, blunt, constricted at the nodes, articulations 2–3 diam.

This species has considerably larger filaments than any other of the subgenus Eucladophora on our coast, and is not likely to be mistaken. There does not appear to be any authentic specimen of the type from New England, the one quoted by Farlow, N. E. Marine Algae, proving to be wrongly marked, and to belong to California. But it has been collected at Atlantic City, N. J., agreeing very well with the specimens distributed in the McCalla's Algae Hibernicae, No. 28, and Wyatt's Algae Danmonienses, No. 226, the main filaments equalling 300 μ diam., though not so densely branched as some of the French specimens.

From its occurrence on the New Jersey coast, there is reason to expect it in New England.

C. HUTCHINSIAE var. DISTANS (Ag.) Kütz.

Kützing, Sp. Alg., p. 392.
Hauck, Deutsch. Meeresalg., p. 453.
De Toni, Syll. Alg, Vol. I, p. 315.
C. diffusa Harv., Phyc. Brit., Pl. CXXX; Nereis Bor.-Am., part 3, p. 83.
Conferva distans Agardh, Syst. Alg., p. 120, 1824.
Conferva diffusa Dillwyn, British Confervae, Pl. XXI; not of Roth.

Main branches long, nearly bare of secondary branches; joints longer than in the type, nodes not constricted.

Habit quite different from the type, but otherwise similar. Found at Gloucester, Mass., and at Long Point, N. J., at which latter locality it is connected with the type by intermediate forms.

MALDEN, MASSACHUSETTS.

EXPLANATION OF PLATE 36. — *Cladophora arcta*: fig. 1, part of filament with descending rhizoids. *C. Hystrix*: fig. 2, tip of filament. *C. spinescens*: fig. 3, filament with recurved branch. *C. albida*: fig. 4. *C. Rudolphiana*: fig. 5. *C glaucescens*: fig. 6. *C. flexuosa*: fig. 7. *C. gracilis*: fig. 8. *C. hirta*: fig. 9. *C. refracta*: fig. 10. *C. expansa*: fig. 11. *C. fracta*: fig. 12. *C. rupestris*: fig. 13. *C. Hutchinsiae*: fig. 14. *C. laetevirens*: fig. 15.

THE BLOOMING OF HEPATICAS.

HARRIET A. NYE.

THE question which of our early spring flowers is entitled to the honor of leading the floral procession is one which has been frequently discussed in various parts of New England. I am not aware, however, that there have been printed records regarding the actual dates at which the Hepatica and other early flowers bloom in central Maine. I submit, therefore, the following memoranda for comparison with the notes of other observers interested in the first appearance each year of these fore-runners of spring.

There is upon our farm a small, sunny opening, somewhat sheltered upon the north and west by woods. It is overgrown by scattered sumachs and blackberries and throughout the season yields numerous treasures to the botanist. In early spring it is a veritable flower garden and it is here that we find our earliest Hepaticas and Erythroniums. We are obliged, however, to go some distance from home for Arbutus.

The first spring flowers to greet us in 1893 were the Hepaticas, in full bloom April 19. I fail to find dates recorded in the year 1894 but in that year both the Hepatica and the Arbutus were rivaled in earliness by a dainty flower much less familiar because quite rare. While searching for Arbutus by the Messalonskee in Waterville the latter part of April, I unexpectedly came upon a few clusters of delicately fragrant whitish flowers the like of which I had never seen before nor have I since. It was plainly a member of the numerous and puzzling order Compositae but the absence of leaves baffled all